Center Independent Research & Development: JPL IRAD

Ground-Based Nanoradian Optical Astrometry and Applications to Navigation

Completed Technology Project (2015 - 2018)

Project Introduction

NASA is now focusing on developing laser communication to allow much higher volumes of scientific data transmitted to Earth from deep space. JPL's first generation optical communications terminal is planned to fly on the Pysche mission for an initial technical demonstration. Looking to the future, utilizing the optical communications infrastructure for navigation and data transmission could both save mass and power by not requiring a separate radio frequency navigation system. Ground-based optical astrometry, one of the four tasks in the initiative "Navigation and Science in the Optical Era," focuses on demonstrating the capability of using optical astrometry from ground terminals to provide the measurements of position of spacecraft in plane-of-sky for optical navigation.
NASA is now focusing on developing laser communication to allow much higher volumes of scientific data transmitted to Earth from deep space. Ground-based optical astrometry, one of the four tasks in the initiative "Navigation and Science in the Optical Era," focuses on demonstrating the capability of using optical astrometry from ground terminals to provide the measurements of position of spacecraft in plane-of-sky for optical navigation.

The goal of Ground-based Optical Astrometry is to demonstrate the feasibility of ground-based optical astrometry at nanoradian (nrad) level precision, comparable to the current state-of-the-art radio frequency (RF) astrometry precision (1-2nrad) obtained from Deep Space Network delta-Differential One-way Ranging (delta-DOR) measurements. This level of performance would be sufficient to enable plane-of-sky angle determinations for navigation purposes. Unlike the delta-DOR measurements, which require coordination between different DSN receivers, optical astrometric measurements could be done more frequently than twice per day and can be taken simultaneously during the time when optical ground terminals communicate with spacecraft. Such an approach would be operationally more efficient and could be a step toward removing some of the RF components from the spacecraft, thereby saving mass and power. It also would open a way for navigating deep-space cubesats, whose population is expected to grow quickly in the near future, without overwhelming the current RF DSN facility for their communications and navigation.

Anticipated Benefits

Psyche mission (for exploration of the asteroid Pysche) is planned to carry JPL's deep space optical communications (DSOC) prototype to demonstrate DSOC capability. A potential application of this task is to provide precise relative astrometry for determining relative position between Psyche and the spacecraft.

For future missions, optical navigation using ground-based optical astrometry can be operationally more efficient and be one step toward removing some of the RF components from the spacecraft, thereby saving mass and power. It

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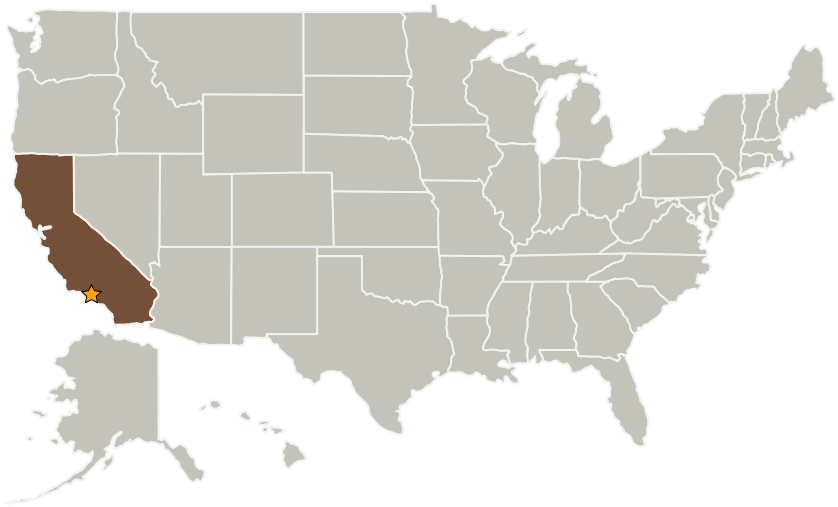
also offers a new way to navigate future deep-space cubesats, whose population is expected to grow fast.

This technology project will demonstrate & validate a reliable, capable, and cost effective optical navigation technology that can be used for commercial space ventures and partnerships with other government agencies.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Co-Funding Partners	Type	Location
Pomona College	Academia	Claremont, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Chengxing Zhai

Co-Investigator:

Michael Shao

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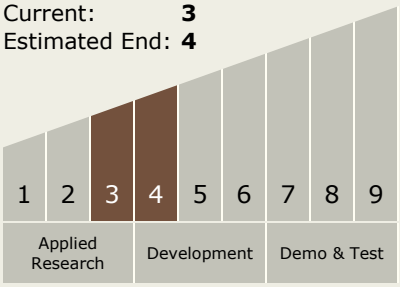
Images

JPL_IRAD_Activities Project Image
JPL_IRAD_Activities Project
(https://techport.nasa.gov/image/28039)

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.1 Optical Communications
    - TX05.1.6 Optimetrics

Target Destination

The Moon

Supported Mission Type

Planned Mission (Pull)